Geomorphic Responses to Stream Channel Restoration at Minebank Run, Baltimore County, Maryland

Start Date: October 1, 2001

End Date: September 30, 2012

Partners: U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Ada, OK; Cary Institute of Ecosystem Studies, Millbrook, NY; and the Baltimore County Department of Environmental Protection and Sustainability

Project Leads: Edward J. Doheny and Jonathan J.A. Dillow

Looking upstream at centerline of stream channel from station 0158397967, Minebank Run near Glen Arm, MD, June 2004, just prior to physical restoration in the gage reach.

Background: Urban streams frequently undergo severe incision and erosion due to flashy streamflows caused by impervious surfaces in the watershed. Such streamflows can lead to unstable sediment dynamics that can limit options for urban stream restoration. Between water years 2002 and 2008, the U.S. Environmental Protection Agency, U.S. Geological Survey, Cary Institute of Ecosystem Studies, and the Baltimore County Department of Environmental Protection and Sustainability collaborated to study the effects of restoration on sediment processes in a selected study reach of Minebank Run, a small urban stream in Baltimore County, Maryland that was restored during 2004 and 2005.

Objectives: To determine the impacts of stream restoration on the physical processes affecting the stream channel and its underlying and adjacent sediments. The study was designed to investigate the hydrodynamics and geomorphology of a selected reach of Minebank Run before and after the restoration.

Approach: The pre-restoration dimension, pattern, profile, and composition of the stream channel at Minebank Run were quantified, and changes over time caused by storms and flooding were assessed. Changes in cross-sectional area, bed elevation, lateral migration of the stream channel, rate of bank retreat, and grain-size distribution were measured throughout the study reach.

Similar post-restoration characterizations of the dimension, pattern, profile, and composition of the stream channel were done and compared to the pre-restoration conditions to assess the natural response to stream channel restoration. Much of the post-restoration geomorphic variability that was observed was primarily due to alternating patterns of sediment storage and removal, and shifting of the channel thalweg, in contrast to channel degradation and widening, and lateral erosion from receding cut banks observed during the pre-restoration monitoring.

Streamflow data from station 0158397967, Minebank Run near Glen Arm, MD, and from a continuous record precipitation gage in the watershed, were used to relate storm events to documented changes in geomorphology of the stream channel during the study period.

Results: Pre-restoration longitudinal-profile surveys indicated rapid and significant changes in the distribution of riffles, pools, and runs within the study reach, indicating continuous alteration of benthic habitat. Changes in channel-bed elevations indicated alternating periods of degradation and aggradation in different locations of the study reach. Boundary shear-stress computations showed erosive power nearly an order of magnitude larger than that of similar non-urban streams, suggesting that restoration of urban streams must address highly variable flow regimes to be successful.

During both the pre- and post-restoration monitoring periods, the analyses indicated that on average, the stream is maintaining the overall slope of the channel bed and water surface at about 1 percent, despite considerable changes in the percentages of riffles, pools, and runs, and changes in the distribution and location of these features. Reduced variability in cross-sectional area and mean depth between surveys conducted from 2006 through 2008 indicated that the stream channel could be establishing a dynamic equilibrium and a more stable geometry after an initial period of geomorphic adjustment observed just after restoration was completed. Composite particle-size analyses of the channel bed from pebble counts over time indicated that sources of fine sediment, possibly from bank erosion, still exist in the watershed despite restoration of the stream channel. The abundance of relatively small bed material sizes in combination with flashy streamflow from urban and suburban runoff likely contributes to considerable changes in grain-size distribution and alternating periods of storage and transport of sand and gravel. The analysis of boundary shear stress indicated comparable magnitudes throughout the study period. However, post restoration, larger increases in mean velocity were required to apply a given increase in force on the channel bed and bank materials, and in turn, to initiate sediment transport.

Looking upstream at centerline of stream channel from station 0158397967, Minebank Run near Glen Arm, MD, October 2004, just after physical restoration in the gage reach.

Publications:

Doheny, E.J., Dillow, J.J.A., Mayer, P.M., and Striz, E.A., 2012, Geomorphic responses to stream channel restoration at Minebank Run, Baltimore County, Maryland, 2002-08: U.S. Geological Survey Scientific Investigations Report 2012-5012, 61 p. Available online at: http://md.water.usgs.gov/publications/sir-2012-5012/index.html

Doheny, E.J., Starsoneck, R.J., Mayer, P.M., and Striz, E.A., 2007, Pre-restoration geomorphic characteristics of Minebank Run, Baltimore County, Maryland 2002-04: U.S. Geological Survey Scientific Investigations Report 2007-5127, 49 p. Available online at: http://md.water.usgs.gov/publications/sir-2007-5127/index.html

Doheny, E.J., Starsoneck, R.J., Striz, E.A., and Mayer, P.M., 2006, Watershed characteristics and pre-restoration surface-water hydrology of Minebank Run, Baltimore County, Maryland, water years 2002-04: U.S. Geological Survey Scientific Investigations Report 2006-5179, 42 p. Available online at: http://md.water.usgs.gov/publications/sir-2006-5179/index.html